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13. ABSTRACT (Maximum 200 words)

This paper compares oral health status and presence of untreated, decayed permanent teeth in abused/neglected children with nonabused/non-neglected controls. The sample comprised 903 children between 5 and 13 years old; 30 were confirmed cases of child abuse and 873 served as controls. Their oral health status was assessed by two calibrated dentists using the DMFS index. Presence of untreated, decayed teeth was determined from the decayed and unfilled component of the DMFS score. The data were analyzed using logistic regression so that the influence of other explanatory variables on oral health status and presence of untreated, decayed teeth could be controlled while the influence of abuse status was evaluated. Results show that abuse status is an important explanatory variable for both oral health status and presence of untreated, decayed teeth. While the impact of abuse status on oral health status is obscured by interactions with other explanatory variables, its impact on the presence of untreated, decayed teeth is clear. Abused children are eight times more likely to have untreated, decayed permanent teeth than non-abused children. Accordingly, it is recommended that confirmed cases of child abuse/neglect should be referred routinely for dental screening as part of their overall rehabilitation.

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A comparison of oral health status and need for dental care between abused/neglected children and nonabused/non-neglected children

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Abstract

This paper compares oral health status and presence of untreated, decayed permanent teeth in abused/neglected children with nonabused/non-neglected controls. The sample comprised 903 children between 5 and 13 years old; 30 were confirmed cases of child abuse and 873 served as controls. Their oral health status was assessed by two calibrated dentists using the DMFS index. Presence of untreated, decayed teeth was determined from the decayed and unfilled component of the DMFS score. The data were analyzed using logistic regression so that the influence of other explanatory variables (sociodemographic characteristics) on oral health status and presence of untreated, decayed teeth could be controlled while the influence of abuse status was evaluated. Results show that abuse status is an important explanatory variable for both oral health status and presence of untreated, decayed teeth. While the impact of abuse status on oral health status is obscured by interactions with other explanatory variables, its impact on the presence of untreated, decayed teeth is clear. Abused children are eight times more likely to have untreated, decayed permanent teeth than nonabused children. Accordingly, it is recommended that confirmed cases of child abuse/neglect should be referred routinely for dental screening as part of their overall rehabilitation. (Pediatr Dent 16:41-45, 1994)

Introduction

In the summer of 1990, the U.S. Advisory Board on Child Abuse and Neglect declared that child abuse and neglect in the United States is a "national emergency." According to the advisory board, the number of cases of child maltreatment has risen from 60,000 in 1974 to 2.4 million in 1989.¹ Failure to provide adequate medical and dental treatment is classified as a form of child neglect.

Previous studies have shown that compared to nonabused, non-neglected children, abused or neglected children are more likely to suffer from failure to thrive, mental illness, severe academic and socioemotional problems, self-destructive behavior, speech and developmental delays, hematological problems, urinary tract problems, severe ocular injuries, infectious diseases (including urinary tract infections, otitis media, conjunctivitis, streptococcal pharyngitis, gastroenteritis, and sexually transmitted diseases), lead poisoning, and signs of physical abuse (such as fractures, burns, head injuries, abrasions, lacerations, and scars).²⁻⁶ Only one study has explored the relationship between child abuse and oral health. In 1986, Badger compared the oral health status of 68 abused/neglected children aged 2-19, stratified by age, to a control group

from a national survey and found no significant differences between the two groups.⁷ This study seeks to determine whether oral health status (as measured by cumulative lifetime caries experience) and dental treatment needs (as measured by the presence of decayed and unfilled teeth) differ between abused/neglected and nonabused/non-neglected children in their permanent teeth holding all other factors constant. That is, this study seeks to build explanatory models for oral health status and dental treatment needs controlling for potential confounders by using regression analysis.

Methods

Sample

Selection of cases. Confirmed cases of child abuse/neglect were drawn from the social services registry at a major military medical center (MMMC). During 1988, this MMMC recorded 315 cases of child abuse/neglect between the ages of 2-19. However, this study selected only those cases that were between 5-13 years of age because accessible controls fell within this age range. This resulted in a case sample of 30 children.

Selection of controls. Controls were drawn from a general oral health survey of 1,235 grade school children (57% of total grade school enrollment) from on-post grade schools at the same military installation. Five children whose names were on the child abuse/neglect registry were dropped from the control group. Then, controls were matched to cases on key demographic characteristics (age of the child, education level of the mother and father, and sponsor's military rank) that previous studies have shown are related to children's oral health status.⁸⁻¹¹

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Measurement

The child's age, gender, and race were noted by the dentist at the time of examination. Rank, number of years of active military service, and type of military unit (combat vs. noncombat) of the child's sponsor; education level of the child's parents; and number of children in the family were collected from self-administered questionnaires attached to the parental consent forms. Oral health status of the children was assessed by two calibrated dentists using the DMFS index for permanent teeth.¹² No radiographs were used. Controls were examined in May 1988 and cases were examined from September to December 1988.

Data analysis

Table 1 describes the outcome and explanatory variables used in model building. Scaling of explanatory variables was done after extensive exploratory data analysis. The data were checked for collinearity by regressing each individual predictor variable against all other predictors in the model.

Using the variables specified in Table 1, logistic regression models for oral health status and for untreated dental decay were derived using backwards stepwise

regression until reduced models were obtained where all remaining variables were significant. The process included searching for significant two-way interactions and quadratic terms.

Results

No evidence of collinearity was found in the data. Tables 2 and 3 present significant coefficients in the final models along with corresponding odds ratios and confidence intervals. The sign on a given coefficient indicates the direction of the relationship of that explanatory variable with the outcome variable. A positive sign denotes a direct relationship, i.e., the explanatory variable enhances the likelihood of the outcome occurring. A negative sign denotes an inverse relationship, i.e., the explanatory variable lessens the likelihood of the outcome occurring. Where appropriate, odds ratios have been adjusted for interaction and quadratic terms. If the odds ratio confidence interval includes one, it is not statistically significant. However, if the interval includes one but is highly skewed towards the right, the effect may still be regarded as important.¹³ Regarding the individual models, the following observations are noted:

Oral health status.

Nearly all of the explanatory variables in this model have a direct relationship with the outcome variable. That is, most of these explanatory variables enhance the likelihood of caries experience in children's permanent teeth. However, the presence of many interaction and quadratic terms makes interpreting the effects of these explanatory variables difficult.

Because sponsor's years of active duty (SPYRSAD) and the number of children in the family (LCHLD) both interact with abuse status (CASE), the influence of these explanatory variables on oral health status cannot be directly interpreted. However, the odds ratio for a categorical variable, such as CASE, can be estimated if levels of the interacting quantitative terms are specified.¹³ In Table 2, mean values of LCHLD and SPYRSAD were used to find that abused children from

Table 1. Description of study variables

Dichotomous outcome variables

DMFS	Presence (1) or absence (0) of caries experience in the child's permanent teeth. Caries experience includes treated and untreated dental decay.
PCDK	Presence (1) or absence (0) of untreated dental decay in the child's permanent teeth.

Dichotomous predictor variables

CASE	Child's abuse status; 0 = not abused or neglected, 1 = abused or neglected.
GENDER	Child's gender; 0 = female, 1 = male.
COMBAT	Type of military unit that child's sponsor is assigned to; 0 = noncombat unit, 1 = combat unit.

Polychotomous predictor variables

RACE	Child's race; W = white, B = black, H = hispanic, and O = other; entered in the models as a series of dummy variables with O being the reference group.
EDM	Education level of the child's mother; EDM1 = some high school or less, EDM2 = high school, EDM3 = some college, EDM4 = college or more; entered in the models as a series of dummy variables with EDM1 being the reference group.
EDD	Education level of the child's father; similar to EDM
RANK*	Enlisted military rank of the child's sponsor; RK1 = E3-E6, RK2 = E7, RK3 = E8-E9; entered in the models as a series of dummy variables with RK1 being the reference group.

Quantitative predictor variables

AGE	Child's age in years.
LCHLD	The log of the number of children in the child's family.
SPYRSAD*	Number of years the child's sponsor has been on active duty.

* RANK and SPYRSAD are composite variables that measure sponsor's education, health care practices, attitudes, values, income, and social status. As such, they resemble what some investigators would call socioeconomic status.

Table 2. Logistic regression coefficients and odds ratios for oral health status (DMFS) model

Independent Variable	Coefficient	P-value	Odds Ratio	95% CI
Intercept	-10.4			
CASE	7.71	0.001	2.20*	(0.90, 5.42)
Age	1.33	0.004	3.60†	(1.52, 8.49)
Rank of sponsor		0.010		
RK2	0.57	0.007	1.77	(1.16, 2.68)
RK3	0.94	0.015	2.56	(1.20, 5.47)
Log Children	0.39	0.071		
CASE = 0	0.39		1.48	(0.97, 2.25)
CASE = 1	-3.17		0.04‡	(0.001, 1.03)
SPYRSAD	0.22	0.27		
CASE = 0	0.21		1.23†	(1.02, 1.49)
CASE = 1	-0.09		0.91§	(0.71, 1.18)
CASE*SPYRSAD	-0.30	0.006		
CASE*LCHLD	-3.56	0.031		
AGE*AGE	-0.05	0.049		
SPYRSAD*SPYRSAD	-0.01	0.010		

* The odds ratio of CASE will vary across values of LCHLD and SPYRSAD due to interactions. We present the odds ratio and confidence interval at mean values of LCHLD (0.89) and SPYRSAD (2.5).

† Adjusted for quadratic term. ‡ Adjusted for interaction with CASE § Adjusted for quadratic term and interaction with CASE

families at mean family size and mean years of sponsor's active duty are 2.2 times more likely than nonabused children to have experienced dental caries in their permanent teeth. Note that the confidence interval for this odds ratio includes one, but it is highly skewed. This suggests the effect may be important despite its lack of statistical significance. Also note that this odds ratio is subject to change as values of LCHLD and SPYRSAD shift.

Interactions of categorical variables with quantitative variables are easier to interpret because categorical variables have fewer values than quantitative variables. For example, in the DMFS model, the dichotomous variable CASE interacts with LCHLD as well as with SPYRSAD. Thus, odds ratios for both LCHLD and SPYRSAD are calculated at two levels—CASE = 0 and CASE = 1. Note, for both quantitative variables, the sign on the coefficients changes as one moves from nonabused/non-neglected children (CASE = 0) to abused/neglected children (CASE = 1).

After adjusting for interactions and quadratic terms,

the impact of LCHLD and SPYRSAD on oral health status ceases to exist for abused children (CASE = 1). Note that for both of these situations, the 95% confidence interval tightly bounds one. For nonabused children (CASE = 0), SPYRSAD has a minimal effect. Even though the 95% confidence interval for LCHLD (CASE = 0) includes one, it is skewed away from one. Thus, while not statistically significant, it may still be important.

RANK is the only explanatory variable in the DMFS model not influenced by higher order terms. Compared to the referent group (E3-E6), children of higher ranking enlisted personnel have greater odds of having had exposure to dental

caries. AGE shows a strong direct relationship to oral health status. As a child's age increases by one year, the child's odds of having experienced dental caries increases 3.6 fold.

Untreated decay model. Because this model has only one interaction and no quadratic terms, it is much easier to interpret. Age, rank, family size, and abuse status all have direct relationships with the outcome variable. The odds that abused compared to nonabused children will have untreated, decayed permanent teeth is strikingly high—8.0.

Table 3. Logistic regression coefficients and odds ratios for untreated decay (PCOK) model

Independent Variable	Coefficient	P-value	Odds Ratio	95% CI
Intercept	-5.57			
CASE	2.08	0.000	8.00	(3.60, 17.7)
Rank of sponsor		0.014		
RK2	2.56	0.005	1.58*	(0.98, 2.56)
RK3	4.11	0.015	7.46*	(1.20, 46.5)
Log Children	0.63	0.024	1.88	(1.09, 3.27)
Age	0.31	0.000		
RK1	0.31		1.36	(1.19, 1.57)
RK2	0.06		1.06†	(0.91, 1.23)
RK3	0.06		1.06†	(0.91, 1.23)
AGE*RANK	-0.25	0.009		

* The odds ratio of rank of sponsor will vary across values of age due to an interaction. Here we present the odds ratio and confidence interval at the mean value of age (8.4).

† Adjusted for interaction with rank of sponsor.

In this model, there is only one interaction—the categorical variable RANK interacts with the quantitative variable AGE. These are the only two variables whose coefficients cannot be directly interpreted. AGE has three coefficients because it interacts with the three-level categorical variable RANK. The influence of age on the presence of untreated, decayed permanent teeth is significant only for the lowest ranking enlisted group (E3–E6).

Because the influence of RANK on the odds of untreated, decayed permanent teeth varies across the quantitative variable, AGE, an age level must be specified in order to calculate an odds ratio. Table 3 shows that in a child of the mean age, the odds of having untreated, decayed permanent teeth is greater in higher ranking groups compared with the referent group (E3–E6). This odds ratio will vary as age changes because of the interaction between AGE and RANK.

Discussion

The major purpose of this study was to determine whether lifetime exposure to dental decay and the presence of decayed and unfilled teeth differ between abused/neglected and nonabused/non-neglected children, controlling for potential confounders. To do this, reasonable models for oral health status and untreated dental decay had to be constructed. Because this study is cross-sectional, it attempts to show association and not causation. However, for many variables the direction of causation may be reasonably inferred. For example, it is certain that advancing age leads to poor oral health status rather than the reverse.

Earlier, mostly bivariate studies of oral health status and untreated decayed teeth have shown that age and socioeconomic status are strong determinants of these outcomes while gender and race are weaker or questionable determinants.¹¹ The logistic regression models built in this study appear to be consistent with these findings. In addition, this study identifies two new factors that influence oral health status and the presence of untreated, decayed teeth—family size and a child's abuse status. The latter finding contradicts an earlier oral health status study by Badger⁷ that did not control for confounders.

This study differs from Badger's study in several ways. First, Badger presented no sociodemographic profile of his study sample, so it is impossible to compare this sample with his regarding other important demographic characteristics, such as sex and race, that may influence the outcome measure. Second, Badger compared his study group to a national sample of school children rather than to a local cohort as this study does. National samples would not exclude abused children. Moreover, national samples would include children with unemployed parents (which would be absent from a sample of military-dependent school children) as well as children from higher income groups (which may be

less prevalent in a sample of military school children). Yet sociodemographic characteristics are known to correlate strongly with oral health status.^{8–11} For this reason, our study employed regression analysis to control for potential confounders that could obscure differences between abused/neglected and nonabused/non-neglected children.

Finally, aside from not controlling for potential confounders, this study went beyond Badger's focus of searching for differences in cumulative lifetime caries experience (oral health status) to look for differences in untreated decayed teeth. While the former is important, the latter should not be overlooked. It is conceivable that abused/neglected children could have had a degree of exposure to dental caries similar to that of their nonabused/non-neglected peers and yet be vastly dissimilar because most of their caries have been left untreated.

Results from this study suggest that abuse status is strongly associated with both oral health status and the presence of untreated, decayed teeth. The increase in odds that abused/neglected children have decayed, untreated teeth when compared with nonabused/non-neglected children is both statistically and practically significant. While the odds for oral health status are not statistically significant, it is heavily skewed to the right, which suggests it is important.

The finding that the odds of untreated, decayed permanent teeth increase with age may at first seem illogical. However, it may be due to increased risk with age. As children in the 5- to 13-year-old age group mature, more of their permanent dentition erupts. The more permanent teeth a child has, the more likely he or she will have at least one tooth that is decayed and untreated.

The finding that the odds of untreated, decayed teeth in children at the mean age increase with socioeconomic status (RANK) also seems counterintuitive. However, this may represent a cohort effect among the children's sponsors. In other words, a junior ranking enlisted sponsor with an 8-year-old child comes from a different generational cohort than a senior ranking enlisted sponsor with an 8-year-old child.

Time trends over the enlisted force show that today's average enlisted soldier is radically different from one of a decade ago. In 1979, roughly half of enlisted recruits scored in Category IV on the Armed Forces Qualification Test (AFQT), a level so low that it was considered untrainable. Current figures show less than 1% have AFQT scores in Category IV.¹⁴ These figures suggest that a socioeconomic cohort effect may exist within the enlisted force. Previous studies have shown that perceived need for dental care varies widely across socioeconomic status.^{15,16} This may explain the positive coefficient on RANK in the untreated decay model.

A major limitation of this study is that it was done on a military population. It is likely that socioeconomic

status (RANK in this study) would have a different influence on the outcome variable among a civilian population where occasional access to free dental care is not available.

Another possible limitation is omitted variable bias. The only variable not directly captured in this study that may influence the outcome is family income. However, this effect may have been captured indirectly with a combination of sponsor's years of active duty and military rank. Omitted variables may cause bias in estimated coefficients.

Conclusion and recommendations

The major finding from this study is that the odds that abused/neglected children have untreated, decayed teeth are 8.0 times greater than nonabused/non-neglected children. Accordingly, it is recommended that confirmed cases of child abuse should be referred routinely for dental screening as part of their overall rehabilitation.

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